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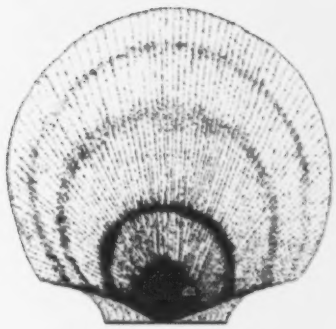
Maritimes Region
Canadian Science Advisory Secretariat
Science Advisory Report 2011/027

ASSESSMENT OF BROWNS BANK NORTH SCALLOPS (*PLACOPECTEN MAGELLANICUS*)



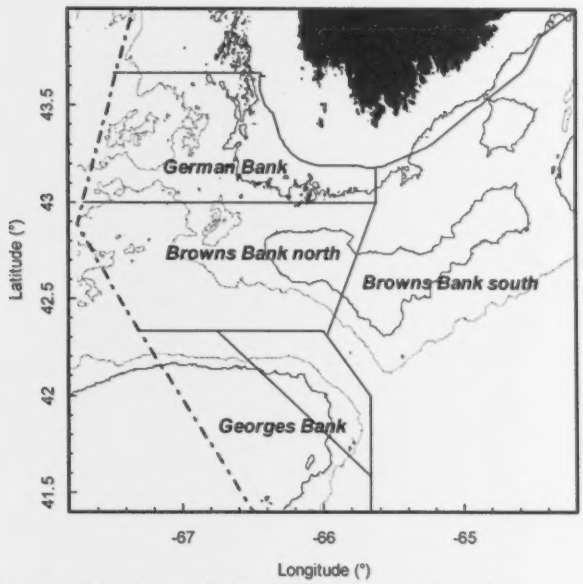


Figure 1. Location of Browns Bank north and south.

Context:

The sea scallop, Placopecten magellanicus, is found only in the Northwest Atlantic, from Cape Hatteras to Labrador. Scallops are aggregated in patches and harvestable concentrations are called beds. Major areas of offshore fishing activity are Georges Bank, Browns Bank, German Bank, the Eastern Scotian Shelf (Banquereau, Middle Bank, Sable and Western banks), and St. Pierre Bank (south of Newfoundland). Scallops prefer a sandy, gravel bottom and occur in depths of 35 to 120 m on the offshore banks.

The offshore scallop fleet consists of wet fish vessels and freezer-trawlers. Generally, these vessels simultaneously fish two New Bedford offshore rakes, 4 to 6.1 m width, one on each side of the vessel.

Annual assessments of the status of the offshore scallop resource take into account the annual survey findings, meat size distribution in the catch, and fishery performance. The management of the main scallop fishery on Browns Bank refers to the northern part of the bank (Fig. 1). Browns Bank south is a marginal growth area for scallops and has separate management measures. The assessment and advice presented in this document use the assessment framework established in 2009 for Georges Bank.

In support of management of the Browns Bank north 2011 scallop fishery, a meeting of the Science Advisory Process was held 8 February 2011 at the Bedford Institute of Oceanography in Dartmouth, N.S., to: (1) assess the status of the resource; and (2) provide harvest advice for the 2011 fishery.

Canada

SUMMARY

- The 2010 TAC was 200 t for Browns Bank north and total reported landings were 201 t.
- The commercial catch rate in 2010 was at the long-term median (1991-2009).
- In 2010, survey catch rates of pre-recruit, recruit and fully recruited scallops were above their respective 19-year (1991-2009) median levels. The 2005 year-class is the largest seen since 1991 and has now started to recruit to the fishery.
- The overall condition factor (meat weight relative to shell height) for scallops on Browns Bank north in 2010 declined from 2009 to 11.05 g/dm^3 and was well below the long term median (12.3 g/dm^3 from 1991-2009)
- Fully recruited biomass, estimated to be 9,096 t in 2010, increased from the 2009 estimate of 5069 t due to the highest recruit biomass since 1991 estimated to be 5,077 t in 2009
- Continued strong recruitment in 2011 will result in a fully-recruited population dominated by younger scallops (95-105mm) and higher exploitation rates at this time could result in a loss of potential yield.
- The 2011 interim TAC of 500 t will result in an exploitation rate of 0.04 and an increase in fully-recruited biomass of 43% to 13,090 t assuming no change in condition factor from 2010.
- Harvest scenarios ranging from 200 t to 1,000 t were examined and all were predicted to yield increases in commercial biomass for 2011 with low probability of decline

BACKGROUND

Rationale for Assessment

A meeting of the Science Advisory Process was held 8 February 2011 at the Bedford Institute of Oceanography (BIO), in Dartmouth, Nova Scotia to assess the status of the scallop stock on Browns Bank in support of the management of the 2011 fishery. Participants included DFO scientists, fishery managers, and representatives of the industry.

The last formal assessment of the Browns Bank north scallop stock was in 1998 but there has never been an analytical assessment model for this stock (Robert and Butler 1998). An assessment framework for Georges Bank scallops was reviewed and accepted at a framework meeting in February 2009 (Jonsen et al. 2009). This same approach was be applied to Browns Bank north this year and reviewed within the Science Advisory Process.

ASSESSMENT

Fishery

The 2010 TAC was 200 t for Browns Bank north and total reported landings were 201 t (Table 1). Based upon preliminary analysis of the 2010 fishery data and the annual stock survey data, an interim TAC of 500 t was set for the 2011 Browns Bank north fishery. The commercial catch rate in 2010 was at the long-term median (1991-2009) (Figure 2). The TAC for Browns Bank north was 0 t in 2009 and 0 t for Browns Bank south since 2008.

Table 1. Landings of sea scallop meats from Browns Bank and total allowable catch (TAC), in metric tons. Since 1998, Browns Bank has been divided into north and south management areas

Year	Catch (t)	TAC (t)
1981	25	--
1982	156	--
1983	106	--
1984	28	--
1985	16	--
1986	5	--
1987	0	--
1988	5	--
1989	337	400
1990	207	200
1991	215	220
1992	454	450
1993	575	600
1994	1403	1400
1995	2002	2000
1996	743	750
1997	500	500

Year	Catch (t)		TAC (t)	
	north	south	north	south
1998	500	98	500	100
1999	200	293	200	300
2000	748	200	750	200
2001	999	99	1000	100
2002	649	98	650	100
2003	1003	97	1000	100
2004	2007	185	2000	200
2005	1068	38	1075	100
2006	912	14	1050	100
2007	1198	1	1200	50
2008	393	0	400	0
2009	0	0	0	0
2010	201	0	200	0

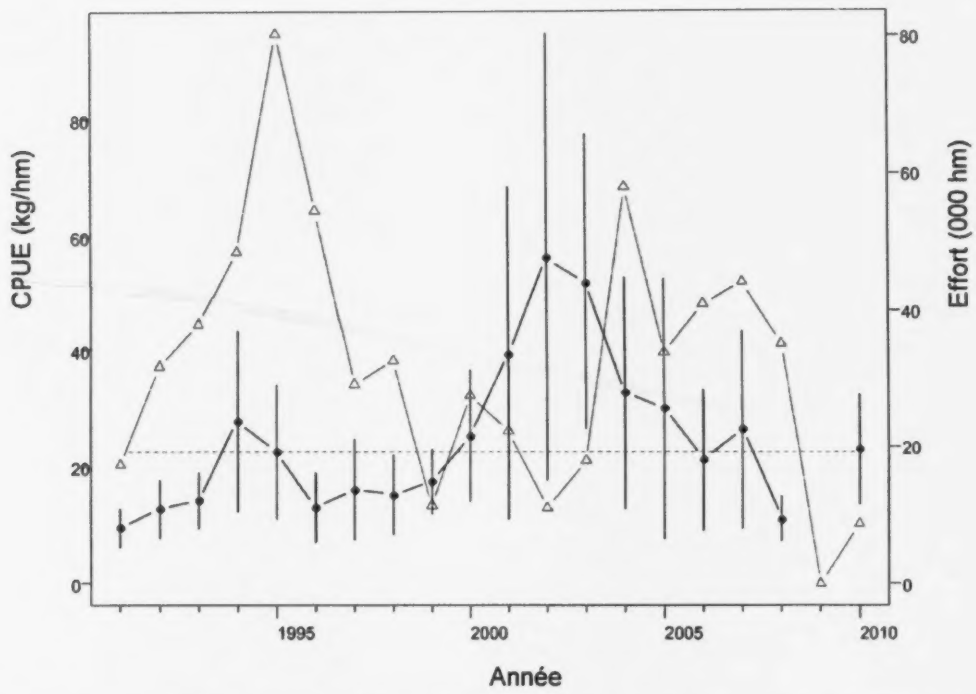


Figure 2. Annual catch per unit effort (CPUE, kg/hm, with standard deviations) (•) and effort (hm) (Δ), for Browns Bank north. The dashed line is the 19-year median CPUE value.

There are no seasonal restrictions for the fishery on Browns Bank north which has lead to variability in the timing of the fishery. In some years the bulk of the catch was landed before the survey in May, while in other years most of the fishing occurred later in the season. Therefore, the population model relates survey data and commercial catch rate to the amount of catch taken between surveys.

Survey

Survey catch rates on Browns Bank north for pre-recruits (<85 mm shell height), recruits (85-94 mm) and fully recruited (≥95 mm) scallops were all above their respective 19-year (1991-2009) median levels in 2010 (Figure 3). The large cohort (2005 year-class) observed in the 15 to 50 mm range in 2007 has grown to the 70 to 105 mm range in 2010 and now straddles all three size ranges (Figure 4). The estimates of recruits in 2009 and 2010 are the highest in the survey series to date, 373 and 267 scallops/tow, respectively. The abundance of fully recruited scallops has increased since 2008 as the 2005 year-class has started to reach commercial size (Figures 3 and 4).

Shell height and meat weight data from the survey were analyzed to see how the condition varies over time. Condition refers to the size of the meat relative to shell height and fluctuates depending on environmental variables that vary annually and spatially. The assessment model accounts for spatial variability using depth as a proxy. The overall condition factor for Browns Bank north in May 2010 was 11.05 g/dm^3 (meaning that on average a scallop with a 100 mm shell would have an 11.05 g meat). This was well below the long term median of 12.3 g/dm^3 (Figure 5).

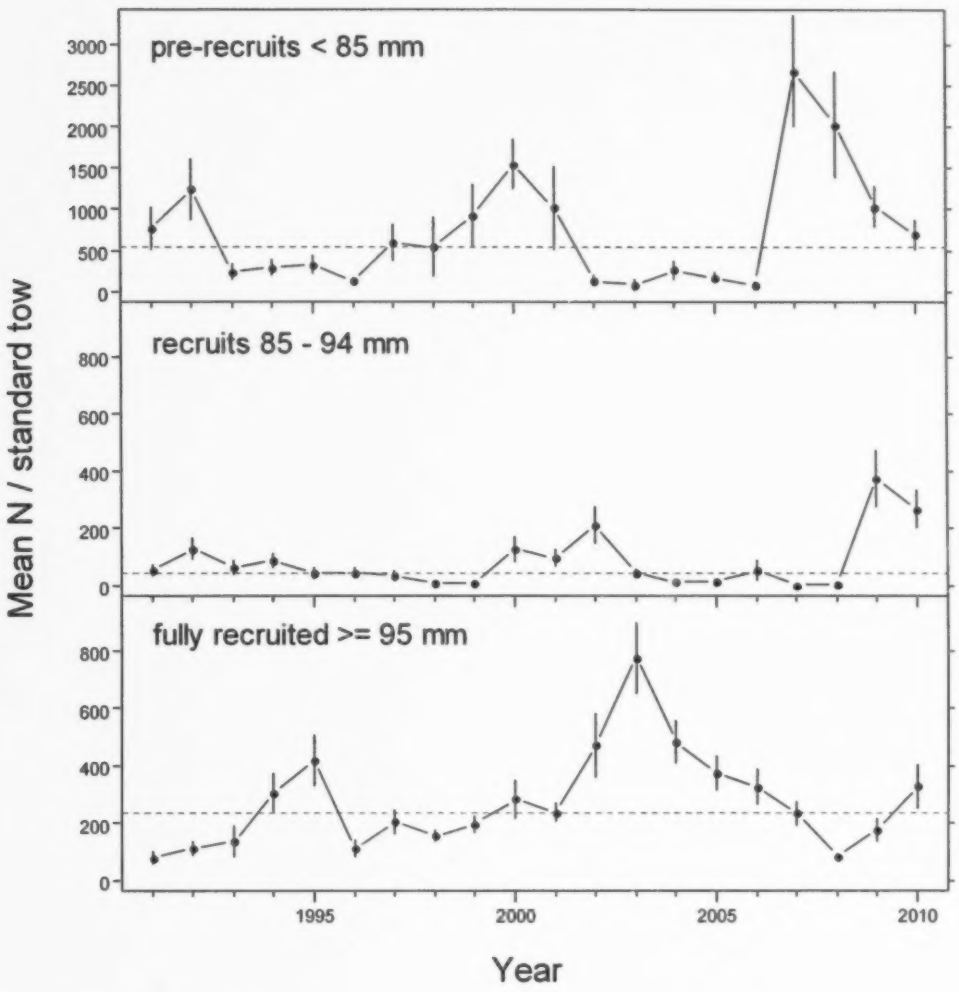


Figure 3. Survey abundance indices (mean number/standard tow) for pre-recruit (<85 mm), recruit (85-94 mm) and fully recruited (≥95 mm since) scallops. The horizontal dashed lines are the 19-year median value for each size class and the solid vertical lines are ± 1 standard error.

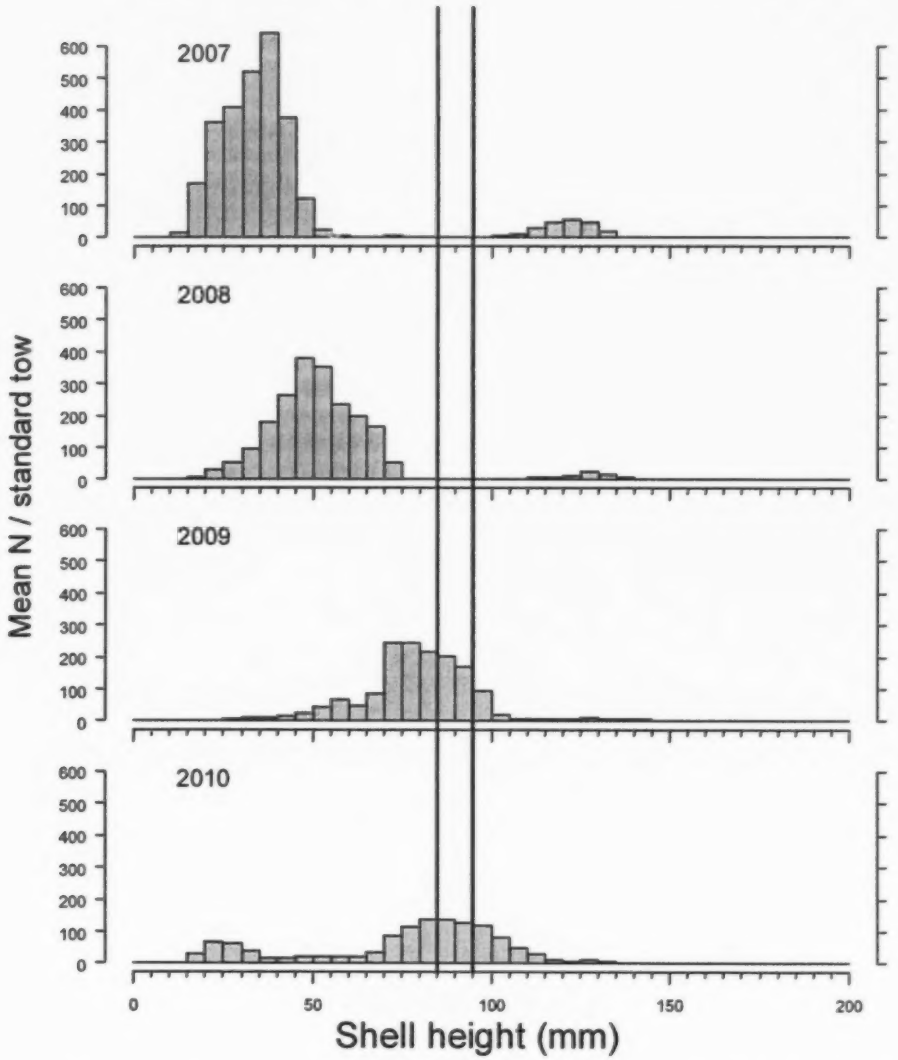


Figure 4. Mean number of scallops at shell height (mean number/standard tow) from the Browns Bank north survey. The vertical lines indicate the divisions between pre-recruit, recruit and fully recruited size classes.

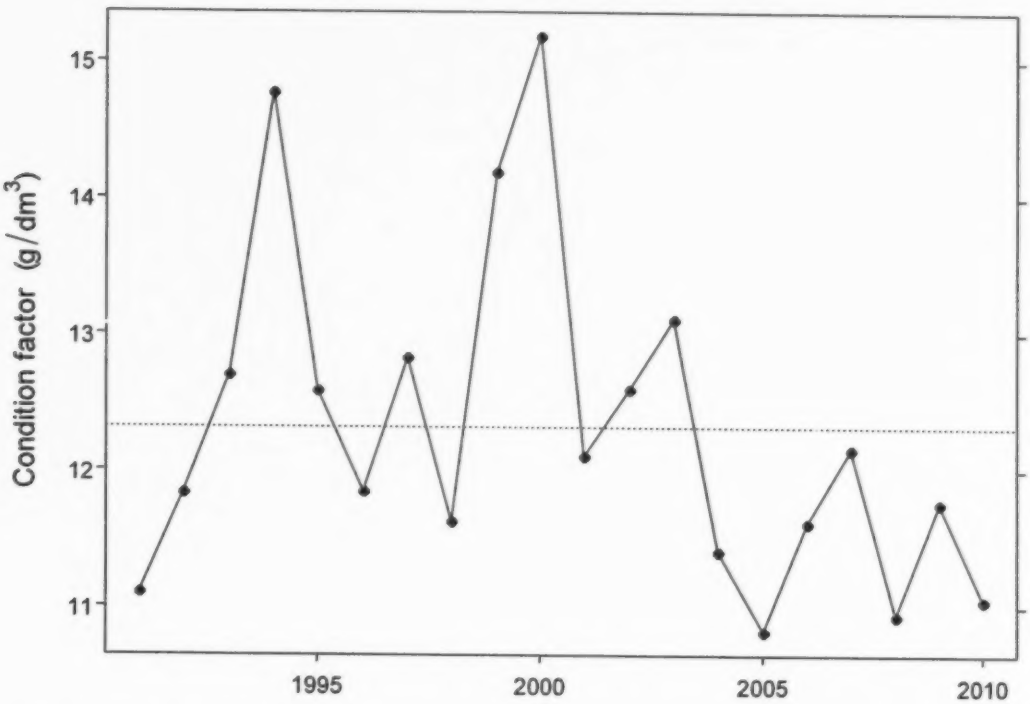


Figure 5. Overall annual condition factor calculated from shell height and meat weight data collected from the May survey. The horizontal dashed line is the 19-year median value.

Population Model

The delay-difference model, described in Jonsen et al. (2009), was fit to the annual survey and commercial catch rate indices on Browns Bank north to estimate commercial biomass and exploitation, as well as to provide 2011 biomass projections and harvest scenarios. Minor changes to the model included considering fishery data between surveys (June in year t to May in year t+1) and including annual condition in the growth estimates.

Fully recruited biomass, estimated to be 9,096 t in 2010, increased from the 2009 estimate of 5,069 t (Figure 6). This was due to the highest recruit biomass since 1991 estimated to be 5,077 t in 2009. The model's forecast for 2011 biomass was 13,090 t, assuming a catch of 500 t (the interim TAC) and no change in condition factor from 2010. This represents an estimated 43% increase in biomass from 2010 (Table 2). Harvest scenarios ranging from 200 t to 1000 t were examined and all were predicted to yield increases in commercial biomass with low probability of decline. However, twenty percent of the fully-recruited biomass was comprised of scallops with shell height between 95 and 105 mm. Scallops of these sizes have a high potential for growth.

There have been three major recruitment events on Browns Bank north since 1991, each leading to a peak in commercial biomass that has essentially sustained the fishery until the next recruitment (Figure 6). When the first event occurred in the mid 1990s exploitation increased sharply as these scallops reached commercial size leading to biomass falling to early 1990 levels until the next recruitment event (increases in biomass in 1999 and 2000 were largely due to improved condition at this time). As a consequence of high exploitation, landings greater than

1000 t resulting from this recruitment event lasted only two years. During the next recruitment event in the early 2000s, exploitation remained low at first giving the stock time to grow, which allowed for four years where landings were greater than 1000 t. These higher landings were at lower exploitation rates than those in the 1990s (Figure 7). Currently, exploitation remains low as the next major recruitment event is occurring.

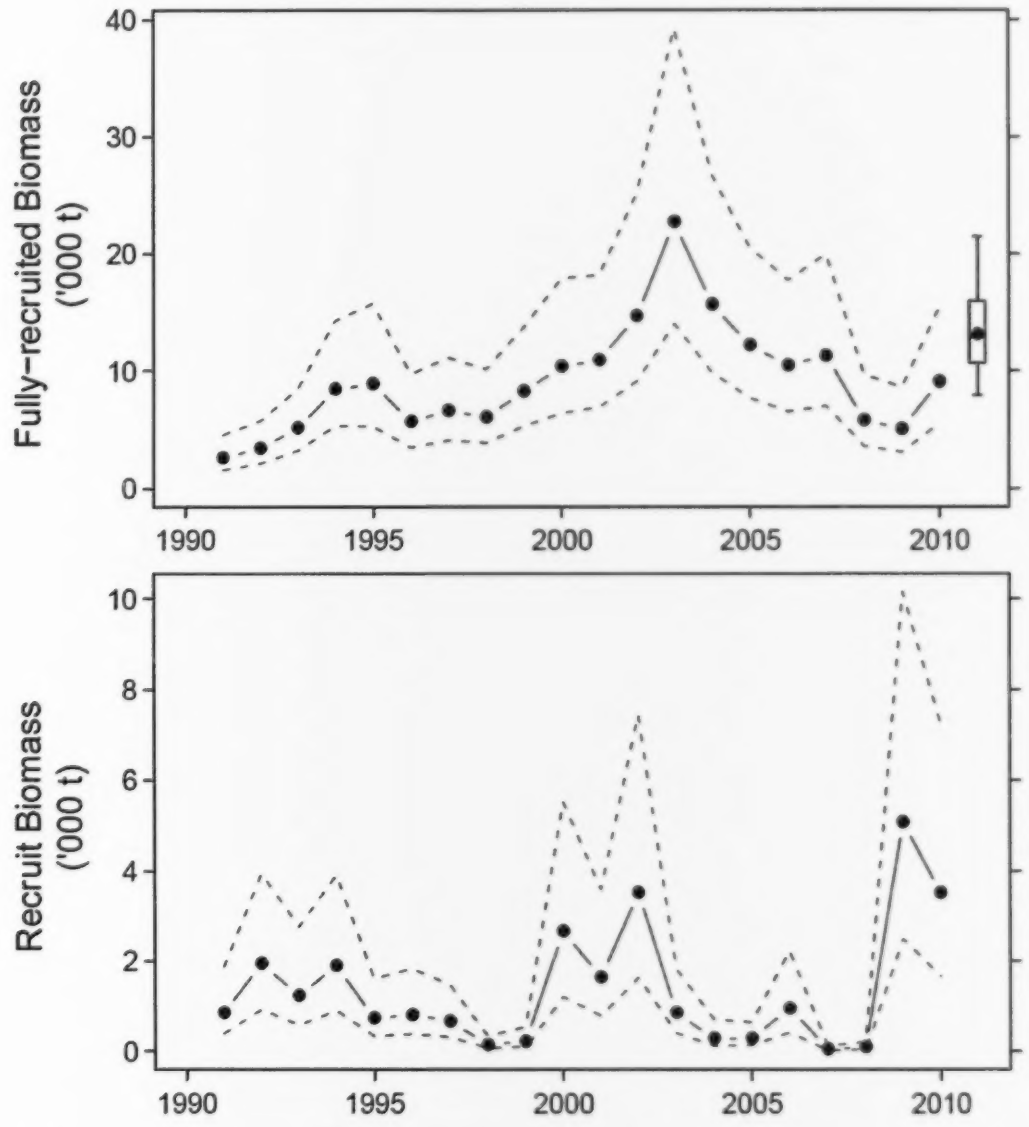


Figure 6. Biomass estimates for fully-recruited scallops and recruits from the delay-difference model. Dashed lines are the upper and lower 95% credible limits. The forecasted fully recruited biomass for 2011, assuming a catch of 500 t, is displayed as a box plot with median (•), 50% credible limits (box) and 80% credible limits (whiskers).

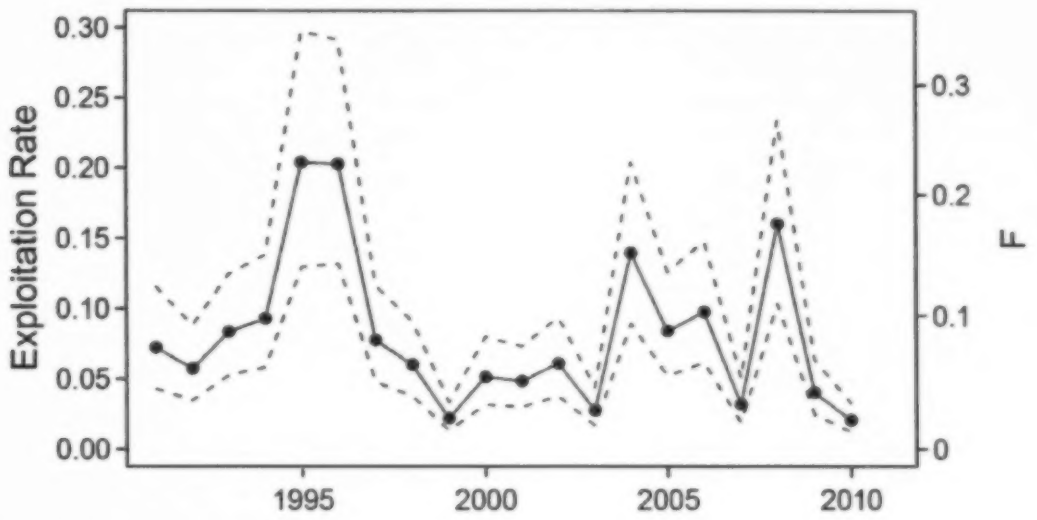


Figure 7. Estimated exploitation rates and instantaneous fishing mortality (F) from the delay-difference model. Dashed lines are the upper and lower 95% credible limits.

Sources of Uncertainty

Condition factor is likely to be an environmentally driven variable and therefore difficult to predict a year ahead. While variability and trends in condition can have a significant influence on commercial biomass, the predictions of next year's biomass presented here assume no change in condition from 2010.

The delay-difference model assumes knife-edged recruitment and natural mortality at 0.1 for both fully-recruited and recruit size classes. In effect, the model assumes that all scallops smaller than 95 mm shell height are not retained and there is no discard or incidental fishing mortality that results from fishing activity. The actual effects of fishing activity on mortality of recruits are uncertain.

There is spatial heterogeneity in the condition and distribution of scallops on Browns Bank north. As a result the fishing fleet targets particular areas that can result in spatial aggregation of fishing effort. This aggregation suggests that exploitation may not be equal over all areas for which biomass was estimated.

The delay-difference model tends to under predict biomass as biomass increases and over predict as it declines. This pattern is typical of many stock assessment models.

CONCLUSIONS AND ADVICE

Continued strong recruitment in 2011 will result in a fully-recruited population dominated by younger scallops (95-105mm) and higher exploitation rates at this time could result in a loss of potential yield. The 2011 interim TAC of 500 t will result in an exploitation rate of 0.04. Harvest scenarios ranging from 200 t to 1000 t were examined and all were predicted to yield increases in commercial biomass for 2011 with low probability of decline (Table 2). However after the

current pulse of recruitment has entered the fishery future harvest scenarios are more likely to result in declining biomass.

Table 2. Harvest scenarios for 2011 in terms of exploitation and expected changes in biomass. Potential catches in 2011 are evaluated in terms of the probability of a decline in biomass. These probabilities account for uncertainty in the biomass forecasts. In this year, all changes in biomass are predicted to be positive.

Catch (t)	Exploitation Rate	Probability of Biomass Decline	Expected Change in Biomass (%)
200	0.02	0.10	46.06
300	0.02	0.11	44.23
400	0.03	0.11	44.15
500	0.04	0.11	42.64
600	0.05	0.13	41.52
700	0.05	0.13	40.17
800	0.06	0.13	39.97
900	0.07	0.15	37.69
1000	0.08	0.16	35.75

SOURCES OF INFORMATION

This Science Advisory Report is from the Fisheries and Oceans Canada, Canadian Science Advisory Secretariat, regional advisory meeting of 8 February 2011 on Browns Bank North Scallop Assessment Additional publications from this process will be posted as they become available on the DFO Science Advisory Schedule at http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm.

Hubley, P.B., A. Glass, A. Reeves, J. Sameoto, and S.J. Smith. 2011. Browns Bank North Scallop (*Placopecten magellanicus*) Stock Assessment. DFO Can. Sci. Advis. Sec. Res. Doc. 2011/042.

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